NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS CONSTRUCTION PROGRAM

HEARING

BEFORE THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

EIGHTY-THIRD CONGRESS

FIRST SESSION

ON

S. 1805

A BILL TO PROMOTE THE NATIONAL DEFENSE BY AUTHORIZING THE CONSTRUCTION OF AERONAUTICAL RESEARCH FACILITIES AND THE ACQUISITION OF LAND BY THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS NECESSARY TO THE EFFECTIVE PROSECUTION OF AERONAUTICAL RESEARCH

APRIL 30, 1953

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Accompanied by—
John F. Victory, Executive Secretary; and
Ralph E. Ulmer, Budget Officer, National Advisory Committee for Aeronautics.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS CONSTRUCTION PROGRAM

THURSDAY, APRIL 30, 1953

UNITED STATES SENATE,
COMMITTEE ON ARMED SERVICES,
Washington, D. C.

The committee met, pursuant to notice, at 10:45 a. m., in room 212, Senate Office Building, Senator Leverett Saltonstall (chairman) presiding.

Present: Senators Saltonstall, Flanders, Case, Duff, Cooper, Hunt, Stennis, and Symington.

Also present: Verne D. Mudge and William B. Darden, of the committee staff.

Senator FLANDERS (presiding in the absence of the chairman). The meeting will come to order.

We have before us the question of the bill authorizing the funds for the National Advisory Committee for Aeronautics, to carry out the construction program contemplated for the fiscal year 1954.

Representatives of NACA have already defended their appropriations requests before the Committees on Appropriations and it is in the interest of orderly procedure that our committee consider the authorization prior to the time that the appropriations are acted upon. The draft of the bill that is before the members conforms with the recommendations of the Director of the Committee and have the approval of the Director of the Bureau of the Budget. The figures are in conformity with the bill reported by the House Committee on Armed Services, H. R. 2322.

Dr. Hugh L. Dryden, Director of the National Advisory Committee for Aeronautics, is present to testify on the proposal.

(The bill referred to is as follows:)

[S. 1805, 83d Cong., 1st sess.; Rept. No. 212]

A BILL To promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That pursuant to subsection (b) of section 1 of Public Law 672, approved August 8, 1950, the National Advisory Committee for Aeronautics is authorized to acquire land, undertake additional construction, and to purchase and install additional equipment at the following locations:

Langley Aeronautical Laboratory, Hampton, Virginia: Transonic tunnel boundary-layer system, variable Mach number facility, and substation expansion, $3,235,290.

Pilotless aircraft station, Wallops Island, Virginia: Preflight jet heat accumulator, $310,000.

Ames Aeronautical Laboratory, Moffett Field, California: Modernization of supersonic tunnel, $990,700.

Lewis Flight Propulsion Laboratory, Cleveland, Ohio: Acquisition of not to exceed ten acres of land, $10.

SEC. 2. Any of the approximate costs enumerated in section 1 of this Act may, in the discretion of the Director of the National Advisory Committee for Aeronautics, be varied upwards 10 per centum and, with the concurrence of the Director of the Bureau of the Budget, by such further amounts as may be necessary to meet unusual cost variations, but the total cost of all work so enumerated shall not exceed $4,536,000.

SEC. 3. There are hereby authorized to be appropriated not to exceed $4,536,000 to accomplish the purposes of this Act.

Senator FLANDERS. Dr. Dryden, we will be glad for you to proceed at this time.

STATEMENT OF DR. HUGH L. DRYDEN, DIRECTOR, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS; ACCOMPANIED BY JOHN F. VICTORY, EXECUTIVE SECRETARY, AND RALPH E. ULMER, BUDGET OFFICER, NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Dr. DRYDEN. Mr. Chairman, the draft of the bill before you covers the legislative authorization for items of construction in the current appropriations bill which has been passed by the House, and is before the Senate.

The draft, of course, has been delayed this year by the second budget review which occurred.

This covers a number of facilities which I might describe in detail.

I would first like to say that the general character of the facilities is that of increasing the speed capabilities of equipment which we already have in operation, and staffed. In one case, the preflight jet heat accumulator, it is proposed to replace equipment which has worn out, and it occurs in this bill because of the size, $310,000, being a little bit large to come out of operating funds.

There is also a land item which I think may puzzle you without having the background, 10 acres of land adjoining the Cleveland Airport, at a price of $10.

Senator FLANDERS. That is a most unusual authorization. I think it ought to be written in letters of gold on parchment.

Dr. DRYDEN. The explanation is this: The Government, of course, has a site, the site of our Lewis Laboratory with a great installation there. A part of the site is not occupied by buildings and, in the installation of additional blind landing facilities for aircraft, that part has been made unusable because they do not want high obstructions with aircraft flying into the airport. The city of Cleveland proposes, in exchange for denying us the future use of the property, the addition of adjoining land which they own. The action has passed the city council, a deed been prepared, and the cost of the transaction, the $10 is a token cost or consideration.

Senator FLANDERS. Now, I have wanted to visit some of these laboratories, but there has always been some reason why I could not when the invitation has been offered.

I wonder if you would tell me, for instance, Are any of the laboratories duplicating each other's work?

There is one being built down in Tennessee, which we were considering the other day.

Senator COOPER. At length.

Senator FLANDERS. Yes; we considered it at length. Langley Field, that is an old one, isn't it, one of the first?

Dr. DRYDEN. It is the first one, yes, sir; the other two were established about 1940.

Senator FLANDERS. How many laboratories and laboratory locations have you, under the National Advisory Committee for Aeronautics?

Dr. DRYDEN. We have three principal locations: at Langley Field, Va.; Cleveland, Ohio; and Moffett Field, Calif. We have a small station on the Atlantic coast, where experiments are made on the aerodynamic properties of wings by the firing of models out to sea, telemetering back measurements.

We have a group at the Edwards Airforce Base, flying the high-speed research airplanes.

Mr. Chairman, I have a booklet that we use for employee relations and recruiting which has a lot of pictures.

Senator FLANDERS. Is it suitable for Senate relations also?

Dr. DRYDEN. Yes, sir; I think so. I have other copies also.

(The copies were distributed.)

Dr. DRYDEN. It is a way in which we answer general questions about the agency.

Senator FLANDERS. May I also make another inquiry: What is the relation of the work and of the laboratories of the National Advisory Committee to the Air Force laboratories?

Dr. DRYDEN. Can you spare the time, 5 or 10 minutes, to go into this?

Senator FLANDERS. I can, if the rest of the members can. I think we ought to know.

Senator STENNIS. I think it is timely; yes.

Dr. DRYDEN. I have a few charts addressed to two questions. I think first, if I may, I will take up the question of this large wind tunnel equipment.

This large equipment was authorized by Congress in Public Law 415, approved October 27, 1949; the Unitary Wind Tunnel Plan Act of 1949 and the Air Engineering Development Center Act of 1949.

Now, let us have the other chart first, if you will.

(Various charts were referred to by the speaker.)

Dr. DRYDEN. This unitary wind tunnel plan was adopted for the purpose of providing the large-scale supersonic wind tunnel equipment which forms the basis for investing millions of dollars in prototype supersonic aircraft.

These tunnels were built for the purpose of development testing of aircraft. So far as these tunnels are concerned, they are to be operated primarily to meet the needs of industry and the military, for development testing. The NACA will operate three tunnels under the unitary plan. Equipment which is now under construction is: a 4- by 4-foot wind tunnel at Langley Field, going up to very high speed. I would prefer not to put the detailed characteristics into the record.

Senator FLANDERS. That is used for models?

Dr. DRYDEN. This is essentially aimed at the missile development problem.

LARGE SUPERSONIC WIND TUNNELS
EXISTING
NACA
UNITARY PLAN
NACA
AIR FORCE
LANGLEY 4' x 4' TUNNEL
LANGLEY 4' x 4' TUNNEL
AEDC 16' x 16' TUNNEL
AMES 6' x 6' TUNNEL
AMES 8' x 6.3' TUNNEL
AEDC 40' x 40' TUNNEL
LEWIS 8' x 6' TUNNEL
LEWIS 10' x 10' TUNNEL
TUNNEL IN OPERATION
TUNNEL FUNDED

Senator FLANDERS. Missiles?

Dr. DRYDEN. Yes, sir.

The 8- by 6.3-foot wind tunnel at the Ames Laboratory aims largely at the supersonic aircraft problem.

The wind tunnel under construction at Cleveland, 10 by 10 feet, again a high-speed tunnel, going up to several times the speed of sound, is aimed at investigations of configurations with the powerplant and propulsion system.

The Air Force wind tunnel at Tullahoma, 16 by 16 feet, is a propulsion wind tunnel aimed at the operation of full-scale powerplants at very high speeds and under operating conditions. Also at Tullahoma, under construction, is a much smaller wind tunnel for extremely high-speed development problems.

These five wind tunnels are part of the coordinated plan which resulted from joint discussions between the Department of Defense and the National Advisory Committee for Aeronautics, immediately following the war when we discovered what the Germans had in the way of supersonic equipment.

At that time a program totaling, I believe, $2.2 billion was talked about. This was very soon boiled down by discussions to something more practical. The first step I think brought it to $1 billion and, to make a long story short, after consideration by very many agencies, including Congress, there was authorized for NACA $150 million. There was appropriated $75 million, which is the cost of these three NACA wind tunnels.

In the case of the Tullahoma part of this operation, the authorization was originally $100 million. It was increased to $150 million. There have been some additional appropriations since. I think that the total authorized amount is in the neighborhood of $165 million or $170 million.

Now, these are wind tunnels whose construction has not yet been completed.

Tullahoma also has an engine-test facility, which I don't show here, which will be the first of their facilities to go into operation.

The only supersonic tunnels we now have completed and in operation, large supersonic tunnels operating in the United States, are these three NACA tunnels. They are very much occupied in development work in support of the existing military-aircraft-development program, and for such research work as we can undertake simultaneously.

These [indicating] are the large supersonic wind tunnels. There are, of course, a large number of smaller supersonic wind tunnels which are not of sufficient size on which to stake the very large sums now required for prototype aircraft.

Until recently, it has not been possible to operate wind tunnels at exactly the speed of sound, because of a formation of a big shock wave, a choking, as it is called.

Now, within the past couple of years, the NACA has invented a new type of wind tunnel which does permit going through the speed of sound; we call this a transonic wind tunnel. For this development, Mr. Stack and his associates at the NACA's Langley Laboratory received the Collier trophy from the President last year.

Many existing wind tunnels are being modified. Congress has appropriated sums in past years to us, and here is the picture:

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TRANSONIC WIND TUNNELS
NACA
MILITARY
PRIVATE
MODIFIED LANGLEY 8' TUNNEL
MODIFIED AIR FORCE 10' TUNNEL
MODIFIED BOEING 8'x12'TUNNEL
NEW LANGLEY 8' PRESSURE TUNNEL
NEW NAVY 7' x 10' TUNNEL
MODIFIED UNITED AIRCRAFT 8'TUNNEL
UNDER MANAGEMENT CONSIDERATION
MODIFIED LANGLEY 16' TUNNEL
MODIFIED COOP. 8½'x12' TUNNEL
MODIFIED AMES 16' TUNNEL
MODIFIED CORNELL 8½'x12'TUNNEL
TO BE FINANCED BY AIR FORCE -
MODEL UNDER TEST
MODIFIED LANGLEY 19' TUNNEL
TUNNEL IN OPERATION
TUNNEL FUNDED

We have modified an existing 8-foot wind tunnel at Langley Field, and have just completed construction of a new 8-foot tunnel of greater speed capacity and operating under pressure, which also is equipped with a transonic throat.

We have in operation a modified 16-foot wind tunnel at Langley. Money has been appropriated and the contracts are in progress modifying the 16-foot wind tunnel at Ames Laboratory, and last year the money was appropriated to modify the 19-foot wind tunnel at Langley.

The Air Force modified the 10-foot wind tunnel at Wright Field.

The Navy has under construction at the David Taylor Model Basin, a 7- by 10-foot transonic wind tunnel.

In private companies, the Boeing Co. has modified one of their tunnels with this invention, an 8- by 12-foot wind tunnel.

The management of United Aircraft has under active consideration the modification of a wind tunnel, at their plant.

The cooperative wind tunnel, which is owned by some 5 or 6 manufacturers, and operated by the California Institute of Technology, is in process of modification.

A similar tunnel at the Cornell Aeronautical Laboratory, in Buffalo, is being considered for modification, and I believe the financing is in the military public works bill. I don't know the present status.

Now, the ones which are drawn with solid lines on the chart are the four wind tunnels now operating and carrying our current load.

This, in brief, is the large wind tunnel picture, and of the modifications. The cost of the modifications has ranged from $1 million to perhaps $9 million. The three large NACA unitary plan supersonic tunnels cost from $15 million to $35 million. They correspond in my way of thinking, to such things as the great forge presses in industry. The reason the NACA and the Air Force are operating these tunnels is that a $35 million wind tunnel cannot be built at each and every plant. This is an attempt to provide the Nation with facilities which are to be operated in the interest of everybody.

NACA is the trustee, if you like, for these tunnels.

Tullahoma is a trustee. At present, the Executive Committee of NACA, with the military, has been working on detailed operating policies for these wind tunnels.

Senator FLANDERS. Now, let me ask: Of the existing wind tunnels, transonic, those four there——

Dr. DRYDEN. Yes.

Senator FLANDERS. How many hours a day do they operate?

Dr. DRYDEN. Well, so far as we are concerned, this is limited by our operating budget. At the present time I think a fair statement is that we are attempting to maintain 2-shift operation, 5 days a week, with occasionally a 3-shift operation to meet the demand for information on specific models.

Senator FLANDERS. The first thought that would occur to me would be that with these tremendously expensive installations, to the extent that they are adapted to the things you want to do, that they ought to be continuously operated, rather than spending millions for new installations.

Dr. DRYDEN. There are two remarks: first, we have sought funds for more intensive utilization for the past 3 or 4 years; if you read the appropriations report of the House Appropriations Committee you

will find that those funds were denied, the personnel were denied to do that.

Senator FLANDERS. Excuse me just a minute.

That reminds me of my visit to the Canadian Pacific carshops in Montreal many years ago. I saw them repairing old wooden cars which would scarcely hold together enough to be repaired, and I asked why they were repairing those wrecks.

Well, they said, "The board of directors will appropriate any amount of money for repairs, but nothing for new equipment."

I am just wondering whether this is a parallel case in which Congress appropriates for new tunnels but does not appropriate for the full use of existing ones.

Dr. DRYDEN. I don't think it is proper for me to argue that question before this committee, as it is an Appropriations Committee matter.

The other point: On this kind of a chart, it is not clear that the tunnels labeled the same, whether two 8-foot or two 4-foot tunnels are not the same by any means. You have to use some designation. In this chart we used throat size. However, the speed capacities, the power capacities, the effective scales of the models that can be tested are quite different. These tunnels have been designed to handle certain jobs; the existing tunnels cannot do the job for which these new tunnels are being built. I think everyone concerned feels that this new equipment is needed. Wind tunnels are no more interchangeable than machine tools, which I think is a field in which you have been for a long time, sir.

Senator FLANDERS. About 50 years.

Dr. DRYDEN. We consider wind tunnels the tools of the men seeking information on how to build airplanes. There are all kinds of tools.

Small jets costing a few hundred dollars are called wind tunnels. You also use the term "wind tunnel" for a $33 million plant, with a 225,000-horsepower drive.

It is a very complex subject to try to go into in detail.

Senator FLANDERS. Is what you were saying very definitely, if you should have funds to make use of the present wind tunnels 24 hours a day, 7 days a week, you would still need the new ones?

Dr. DRYDEN. I am trying to say that. We would like to use our existing equipment to the limit.

It takes a long time to design and build new tunnels. We could use all this new equipment now, if we had it; in this interim period we have been urging to use what we now have to the greatest possible extent.

Senator FLANDERS. Now, just one other thing: I missed something in your earlier statement. What is the difference between transonic and supersonic?

Dr. DRYDEN. Transonic relates to speeds around the speed of sound, from speeds of the order of say 600 miles an hour to 800 miles an hour.

Senator FLANDERS. Past the barrier?

Dr. DRYDEN. Through the so-called sound barrier.

Supersonic tunnels go on up, in some cases, to 4 or 5 times the speed of sound, or around 3,000 miles per hour.

Depending on how much time you have, I would like to go into the question of our relations with the military and the broad subject of research and development.

Senator FLANDERS. I asked you about that.

Dr. DRYDEN. I think this is a subject which is very generally misunderstood. It occurs because we speak of the research and development work and we talk about an appropriation of one-billion-six-hundred-some-odd million, for research and development.

Of this 1.6 billion, about 930 million is for aeronautical, and the rest is for ordnance, tanks, guns for the field forces, and so forth. Roughly half of the military research and development is for aircraft and missiles. Of that nine-hundred-and-some-odd million, about 25 to 30 million is on research, and the rest is on development.

Now, the word "research" comes first in that, and often you leave off the "development."

TECHNICAL AREAS

Actually, 97 percent of that money is spent for development, which means building experimental aircraft, experimental engines, experimental missiles, experimental ordnance material, and 3 percent is for research.

This is the first point I want to make: that of the funds which are called "research and development" in military appropriations, only about 3 percent is research, and 97 percent is development.

Now, the field in which the military does research and also in which the NACA does research is illustrated by this chart. There is no quantitative significance. I don't have the figures as to how much

money the military spends of each of these 12 fields. It simply shows the fields of work: aerodynamics, or the study of airflow, the lift and drag of wings, and so forth; work on powerplants, and related research; aircraft structures, the field which relates to making the airframes strong enough—we haven't thought of a good word for the layman, if we call it "structure" sometimes it gives the wrong impression, and if we say "construction" it sounds like we are building aircraft—what it refers to is making the airplane or missile strong enough to stand the necessary pressures; armaments and fire control; flight instruments; crew training and protection from cold, noise, radiation, and so forth; navigation; electronics; photography; air-base equipment and operation; industrial processes; and medicine and biology.

So the 25 or 30 million is spread over some 12 fields. NACA's work is confined primarily to these three fields: aerodynamics, powerplants, and aircraft structures.

Now, quantitatively, the next chart shows how much money we spend, and how much the military services spend in these three fields of research.

Here is a scale. This is $30 million.

This is what NACA spends for aerodynamics, powerplants, and for this field of aircraft structures; our total operating budget is $53 million in the 1954 bill. The military spends in these same fields $10,500,000, as indicated by these blocks.

There is an important difference which I cannot show readily on the chart. Most of the research carried on by the military arises from problems of existing airplanes—an F–89 has trouble, or some other plane has difficulties. Then contracts are started with universities or somewhere to solve those difficulties, or to do research having a bearing on those difficulties.

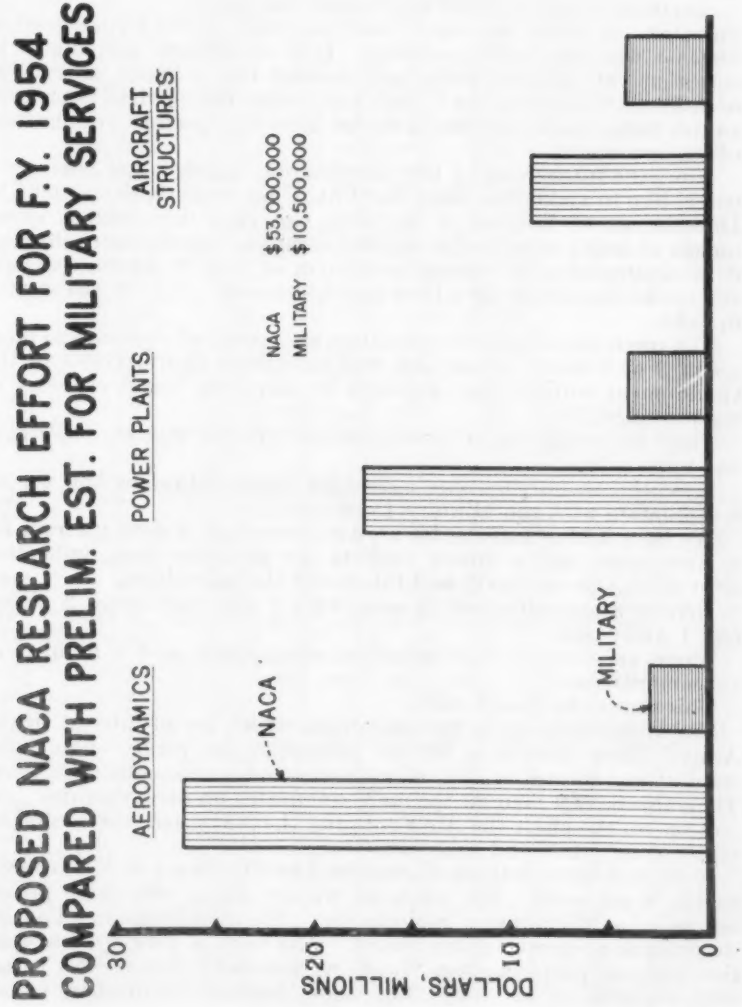
Our job is to build up the general information applicable to all kinds of aircraft. I think one example may make clear the difference.

From the point of view of the expert in airflow, the best place to put the inlet for the airflow of the engine is at the nose, as in the F–86. Then the pressure recovery is very good. However, there is the fellow with the guns, who wants to put the guns in the nose of the plane; the fellow with the radar wants to put radar in the nose of the plane; so that for a night fighter, for example, it may be impossible to put the inlet in the nose, so they put it in the wing root, or in a scoop outside.

Now, the designer who has to design an airplane for a particular purpose and make all these compromises, wants to know all he can about air inlets located at various places on the airplane, which are most efficient, and what penalties are suffered if he puts it here or there, so that he can balance his design.

The NACA's business is to give him that information, to try out configurations of air inlets, and to see how they work in various places.

On the military side, they are more likely to have an inlet to a particular plane that is not working just right, or they think can be improved, so the military research is more closely alined to a particular design. Our job is to furnish the underlying information which can be used in the design of fighters or bombers or even civil aircraft. We have that responsibility, although now of course a very major share of the effort is military.


PROPOSED NACA RESEARCH EFFORT FOR F.Y. 1954
COMPARED WITH PRELIM. EST. FOR MILITARY SERVICES
DOLLARS, MILLIONS
30
20
10
0
AERODYNAMICS
POWER PLANTS
AIRCRAFT STRUCTURES
NACA
MILITARY
NACA $53,000,000
MILITARY $10,500,000

This [indicating] is the dollar size of possible duplication and, to be as honest as I know how to be, I have expressed the view there is no duplication that I know of on major projects. If you talk about contracts with universities, we do uncover occasionally cases of duplication, and we do correct them as we discover them.

Anything connected with the Department of Defense is a very big operation, as there are many, many agencies in the Department of Defense who can make contracts. It is exceedingly difficult to be sure that you know of every last contract that is made, and we do occasionally find cases; but I think I am conveying the right impression to you today when I say that I do not know of any case of duplication of major projects.

Now, the mechanism of this coordination, which is not control—I would like to make this clear, the NACA has no authority to tell the Department of Defense or anybody else that they cannot spend money or make a particular contract—but the coordination, the way it is accomplished is through a system of NACA committees and subcommittees which have been in existence since NACA was started in 1915.

The committees and subcommittees are groups of experts who meet about 2 or 3 times a year and who contribute their services to the Government without pay, although we pay their travel expenses to the meetings.

They are composed of three principal groups: military, industry, and university.

Now, this was brought up [indicating diagram] to show how we get coordination with the Military Department.

We have a blue uniform for an Air Force man, a dark unifrom for a Navy man, and a brown uniform for an Army man [indicating color of objects on chart], and this shows the individuals.

Here is a committee of 22 men, with 2 Air Force men, 2 Navy, and 1 Army man.

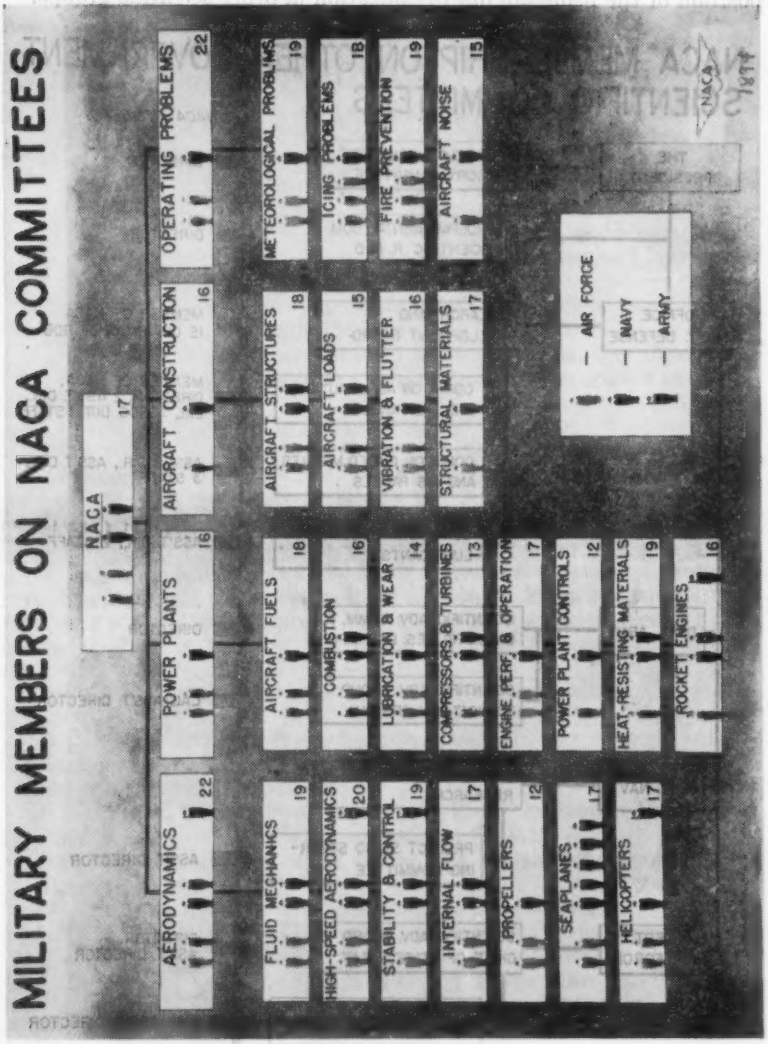
There are four of these principal committees, and a number of subcommittees.

This shows the distribution.

The Army men are in subcommittees which are of interest to the Army. They have men on the helicopter, the rocket engine, the stability and control, and the high-speed aerodynamics subcommittees. They also have a man on the main committee on aerodynamics. As you see on the chart the Air Force and the Navy are represented on all the committees and subcommittees.

Now, it is through these discussions 2 or 3 times a year that coordination is achieved. We tell what we are doing, and these people tell us what their major projects are. We discuss them. Usually we produce no great written record. The work is done by conversation between people saying, "Look, we are doing this, it isn't necessary for you to do that;" the whole business is handled rather informally.

This is one mechanism within our organization.


MILITARY MEMBERS ON NACA COMMITTEES
NACA 17
AERODYNAMICS 22
FLUID MECHANICS 19
HIGH-SPEED AERODYNAMICS 20
STABILITY & CONTROL 19
INTERNAL FLOW 17
PROPELLERS 12
SEAPLANES 17
HELICOPTERS 17
POWER PLANTS 16
AIRCRAFT FUELS 18
COMBUSTION 16
LUBRICATION & WEAR 14
COMPRESSORS & TURBINES 13
ENGINE PERF. & OPERATION 17
POWER PLANT CONTROLS 12
HEAT-RESISTING MATERIALS 19
ROCKET ENGINES 16
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AIRCRAFT STRUCTURES 18
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AIRCRAFT NOISE 15
— AIR FORCE
— NAVY
— ARMY
NACA

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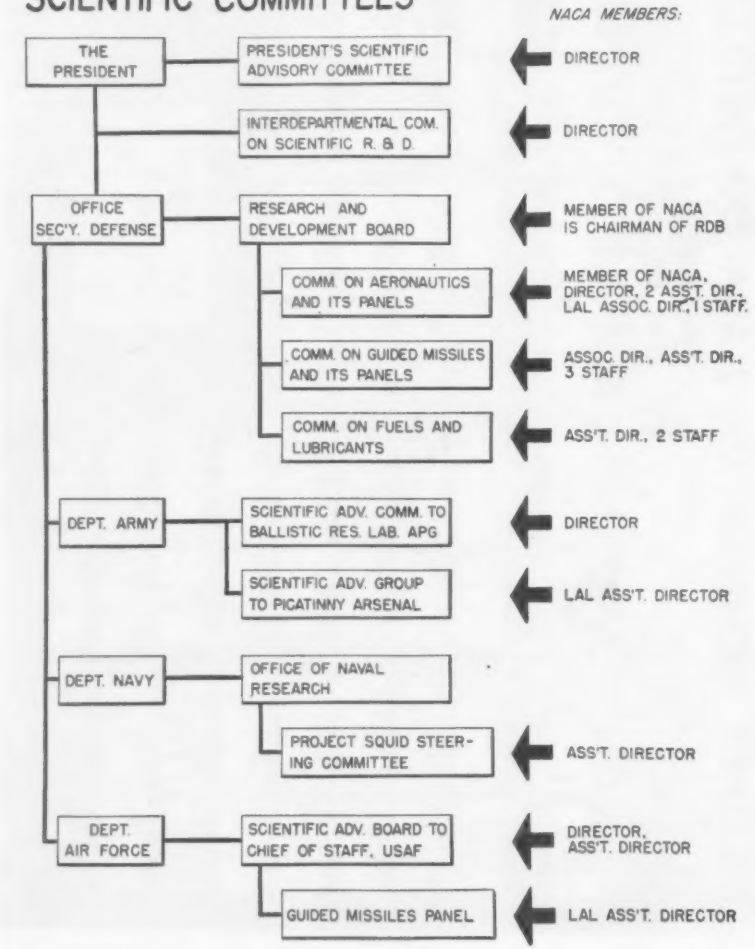
I don't know what the situation will be in the Department of Defense when the pending reorganization is made, but as of today these are the various scientific committees in the Department of Defense on which NACA is represented. This chart also shows the position of the people in our organization in other scientific groups.

NACA MEMBERSHIP ON OTHER GOVERNMENT SCIENTIFIC COMMITTEES


NACA MEMBERS:
THE PRESIDENT
PRESIDENT'S SCIENTIFIC ADVISORY COMMITTEE
DIRECTOR
INTERDEPARTMENTAL COM. ON SCIENTIFIC R. & D.
DIRECTOR
OFFICE SEC'Y. DEFENSE
RESEARCH AND DEVELOPMENT BOARD
MEMBER OF NACA IS CHAIRMAN OF RDB
COMM. ON AERONAUTICS AND ITS PANELS
MEMBER OF NACA, DIRECTOR, 2 ASS'T. DIR., LAL. ASSOC. DIR., 1 STAFF.
COMM. ON GUIDED MISSILES AND ITS PANELS
ASSOC. DIR., ASS'T. DIR., 3 STAFF
COMM. ON FUELS AND LUBRICANTS
ASS'T. DIR., 2 STAFF
DEPT. ARMY
SCIENTIFIC ADV. COMM. TO BALLISTIC RES. LAB. APG
DIRECTOR
SCIENTIFIC ADV. GROUP TO PICATINNY ARSENAL
LAL ASS'T. DIRECTOR
DEPT. NAVY
OFFICE OF NAVAL RESEARCH
PROJECT SQUID STEERING COMMITTEE
ASS'T. DIRECTOR
DEPT. AIR FORCE
SCIENTIFIC ADV. BOARD TO CHIEF OF STAFF, USAF
DIRECTOR, ASS'T. DIRECTOR
GUIDED MISSILES PANEL
LAL ASS'T. DIRECTOR

I am a member of the President's Scientific Advisory Committee, and the Interdepartmental Committee on Scientific Research and Development. I am also a member of the Aeronautical Committee of Research and Development Board, and have contact with the

Ballistics Research Laboratory of the Army, and am on the Scientific Advisory Board to the Chief of Staff of the Air Force.

The NACA Associate Director is on the Guided Missiles Committee of the Research and Development Board, and so on.

You can see the list here.

This is where we know what the military are talking about in their own councils, and by this contact we get as much information as you can get from this type of mechanism about what is going on in both places. I think I am not misleading you when I say there is no duplication of any major project, although we occasionally find cases where it is desirable for one or the other of us to discontinue something because the other is doing it.

I did not bring over any letters. We do have a few cases documented. I didn't bring those, as I thought you would not want to clutter up your record with what might be presumed to be selected letters; but I am trying to give you as fair a statement as I know how to make on the duplication question.

Senator FLANDERS. Do you have any other point you wish to bring out in your presentation?

Dr. DRYDEN. Not unless there are some questions, Mr. Chairman.

Senator FLANDERS. I have one other question, the answer to which I will allow 1 minute.

What is a preflight jet heat accumulator?

Dr. DRYDEN. Let me put it this way: When an airplane or missile goes through the air very fast, they heat up—you know how meteorites burn up in the atmosphere.

Senator FLANDERS. Yes.

Dr. DRYDEN. In the ordinary wind tunnel, when you get a high speed by expanding air at considerable pressure at average temperature, the air cools off in the testing section of the wind tunnel, and you have a low temperature. This piece of equipment heats the air before sending it through the nozzle so that it comes out at the right temperature.

Senator FLANDERS. You have made your case within the stated time.

Do you have any questions, Senator Hunt?

Senator HUNT. I have one question which won't take 10 seconds.

You say this bill has passed——

Dr. DRYDEN. The appropriations bill passed the House, the authorization has been reported favorably to the House.

Senator FLANDERS. In other words, the authorization comes after the appropriation?

Dr. DRYDEN. I think I might make this statement to you: For something like 35 years of its existence there was no separate authorization bill passed for this type of item. There was authorization only through the appropriation language. Three years ago the House Armed Services and Appropriations Committees decided that we ought to follow the same practice as the Military Department and submit separate authorizing legislation. They did, however, informally agree that we should submit each year simultaneously the authorizing legislation and appropriation legislation to be considered concurrently.

Senator HUNT. The situation at this time is that the appropriation has passed the House, and the authorization has been favorably reported?

Dr. DRYDEN. Yes.

Senator HUNT. Thank you.

Senator FLANDERS. Senator Cooper.

Senator COOPER. Following the chairman's example, I will ask you as the first item: What is the "variable Mach number facility"?

Dr. DRYDEN. This is a small research facility consisting of storage tanks for air, some pipe, and a nozzle for producing a small very high-speed air stream whose speed can be varied.

Senator COOPER. I would like to ask this question: After your research and your planning, to whom and how do you make the data available?

Dr. DRYDEN. We have three methods of making our results available.

One is through the medium of classified and unclassified publications. These are distributed to industry and the military departments on the basis of their need for the information.

This has all the defects of getting information to anybody through the printed page.

A second procedure that we have found very effective is through conferences of the technical people who are concerned with a technical field.

Now, we have two forms of those: one is a more general type of meeting which will be in progress next week at Langley, to which many of you I think have been invited, which attempts to give to the executive level a broad picture of what we are doing, and what the problems are; the second is for the technical specialists, where we give summary papers reviewing the state of knowledge right up to the latest test run.

Senator COOPER. To people in private industry?

Dr. DRYDEN. People in industry and in the military services.

The third method, although informal, is a very effective one. A company has a particular problem; they send their engineers to our laboratory, and they sit down around the table with our people and discuss their problems.

We are in the business of helping everybody do the best possible job. We pride ourselves that we avoid leaks of contract information from one contractor to another. We have nothing to do with who gets the contract. Whoever gets it, we work with them to make it the best possible equipment.

Senator COOPER. How would the research and development work of private companies compare, and this is the only way I can state it first, in cost, to what the Government is doing?

Dr. DRYDEN. This is a figure which is very difficult to get at. The research done by companies is always incidental to and charged to the development of an airplane and, without getting into the accounts of the companies, it would be very hard to segregate it.

Senator COOPER. Thank you, sir.

Senator FLANDERS. Senator Case.

Senator CASE. Mr. Chairman, sorry I didn't hear the first part of the discussion. The question I have to ask may be a repetition and, if it is, I hope the answer will be very brief.

I have been familiar with the work of NACA for a number of years, having been a member of the Appropriations Committee for independent offices, in the House, at the time the decision was made that

you should get authorizations; in fact, I think you got your appropriations from independent offices back when I first went in the committee in 1939.

Dr. DRYDEN. That is correct.

Senator FLANDERS. Off the record.

(There was a brief discussion off the record.)

Senator CASE. I remember the discussion in the House Appropriations Committee 3 years ago when it was decided that the practice should be followed of getting authorizations, legislative authorizations, for major improvements, rather than just handling them through an appropriation.

One question I want to ask, and again, if it is repetitious, I hope the answer will be brief:

What is it that you expect to do or to be able to do with the modified 16- and 19-foot tunnels that you will not be able to do with these smaller types?

Dr. DRYDEN. The 19-foot tunnel is directed at the problems of vibration and flutter of aircraft operating in this region near the speed of sound.

It will have this transonic throat. The models in it will be not only similar in their external shape to the aircraft, but they will be scaled down structurally so that the twisting of the structure under airloads and its ability to vibrate and flutter will also be simulated.

I think you have perhaps read of accidents where there has been a complete disintegration of aircraft.

You have all seen flutter on a venetian blind in an opened window, where you have a rapid vibration of the blind.

Unfortunately, airplanes that seem very rigid sometimes do this, and every company has to maintain a group to study this problem to be sure that theirs will not flutter. We must provide basic research data to assist these groups in the solution of their problems.

Senator CASE. And it is not practical to do this in one of the existing tunnels?

Dr. DRYDEN. The size of the model would be far too small.

Senator CASE. That is all.

(Chairman Saltonstall assumes the chair.)

The CHAIRMAN. Are there any further questions?

Senator STENNIS. I want to see if I understand that flutter.

You mean it reaches a point where it disintegrates; it cannot stand the strain?

Dr. DRYDEN. Yes; the structure begins to deform and pick up energy from the wind. The simplest illustration is a flag. You have seen a flag in a strong wind. It doesn't hang out straight behind the mast——

Senator FLANDERS. It duplicates that waving or fluttering?

Dr. DRYDEN. Look at these photographs here. This is what happens to a wing when it flutters. These pictures were taken by a high-speed motion-picture camera. You can see what may happen to a high-speed aircraft, and that is one of the worries of a designer.

Senator STENNIS. We read of 1 or 2 cases where there was a disintegration. Was that a victim of that same development; is that right?

Dr. DRYDEN. Here is what I mean by it. Here is a model fluttering in the wind, in this succession of motion pictures.

You see it is getting pretty badly out of shape, in pretty bad condition over there. These are successive frames of the motion picture of the wing. You see the waving and bending, and finally it will break.

Senator STENNIS. Did you make that, through the wind being forced through there?

Dr. DRYDEN. Yes; it happened in the wind tunnel. You can get it to happen with flexible models at low speed, but we want to study the effect on very stiff airplanes built for high speed. I might also say there is a pretty good bit of theoretical information on the supersonic speed, but in the region right around the speed of sound we have to tackle that experimentally because the theories are not very valid in that region.

Chairman SALTONSTALL. Are there any further questions?

Senator SYMINGTON. I would like to ask a few.

Chairman SALTONSTALL. Senator Symington.

Senator SYMINGTON. Who runs the NACA?

Dr. DRYDEN. The NACA, the top body, is a group of 17 people appointed by the President. Their names are given, I think, in this [indicating document].

Senator SYMINGTON. I know who the people are.

What is your line of authority in your operation?

Dr. DRYDEN. The first act creating the NACA was in 1915.

Senator SYMINGTON. I am talking about your authority, your operating authority.

Dr. DRYDEN. Under the committee?

Senator SYMINGTON. Yes.

Dr. DRYDEN. The committee appoints a Director, an Associate Director, and an executive secretary. The staff is under Civil Service. About half of the employees are in the skilled trades and operate under wage boards as far as their salaries are concerned.

Senator SYMINGTON. Is the operation run at cost?

Dr. DRYDEN. Well, it is a——

Senator SYMINGTON. Is it a Government operation?

Dr. DRYDEN. It is a Government agency, run like any other Government bureau.

Senator SYMINGTON. Who sets the scale?

Dr. DRYDEN. The Civil Service Commission, in all cases, except for these wage-board employees whose wage rates are established by wage boards to meet locality rates.

Senator SYMINGTON. What you are doing here is asking for additional appropriations; is that correct?

Dr. DRYDEN. This bill is authorizing legislation for our 1954 construction program.

Senator SYMINGTON. You are asking for approval of money——

Dr. DRYDEN. Yes; the appropriation item is in the 1954 appropriation bill.

Senator SYMINGTON. Has this been passed by the Bureau of the Budget?

Dr. DRYDEN. Yes; the money is in our appropriation bill and this legislation has been passed by the Bureau of the Budget.

Senator SYMINGTON. The Bureau of the Budget approves this request; is that right?

Dr. DRYDEN. That is correct.

Senator SYMINGTON. How do you coordinate with the Department of Defense? In other words, do you have anyone—suppose you want to do a job, and the Department of Defense or one of its component parts doe not want you to do it; is it your decision or is it theirs?

Dr. DRYDEN. They are represented to the extent of 5 people of the 17 that comprise the main Committee. The Chairman of the Research and Development Board, 2 officers of the Air Force, and 2 from the Navy are all members of the NACA, so that they can stop it at that point.

I described in great detail the——

Senator SYMINGTON. I was here when you talked about that.

Dr. DRYDEN. I beg pardon.

Senator SYMINGTON. In other words, How much of your work is military and how much is civilian?

Dr. DRYDEN. This is very difficult to give in definite terms, because the same work can be applied to military as well as to civilian aircraft.

Let me take an example: One of the very interesting jobs we have been doing is to work on the sources of fires in the crashes of airplanes. This work has been released to the public. We have crashed war-weary planes supplied by the Military Department, instrumented them enough to find out where the fires start, applied a preventive measure to keep the fires from starting in that way, tried some more to develop other sources of fire, and looked toward other types of protective measures.

Now, the military is very greatly interested in this work, as well as the civilians, so it is difficult to tell how much of our work is for each.

Senator SYMINGTON. Have you ever figured out how much you think the military work amounts to and the civilian work, in percentage of total business?

Dr. DRYDEN. I think the only figure I can give you is this: On the order of 15 percent of this $53 million budget will be spent on development work on specific airplanes, missiles and power plants, at the request of the Military Department.

Senator SYMINGTON. Fifteen percent of $53 million?

Dr. DRYDEN. Yes.

Senator SYMINGTON. $53 million is the total request for operating——

Dr. DRYDEN. $53 million is our operating budget for 1954.

Senator SYMINGTON. Is that all the money you request for operating?

Dr. DRYDEN. That is correct.

Senator SYMINGTON. As I understand it, the Department of Defense has about a one-third representation on your Board, and you are doing about 85 percent of the work for them; is that correct?

Dr. DRYDEN. I would not state it that way. I don't know how to allocate the work on jet engines, for example. We are going to have jet civil aircraft and jet military aircraft, and if we do research on improving jet engines, it may be regarded as charged to either military or civil, or both. Of course, the main incentive of a lot of our work under the present cold-war conditions is the military program, support of the military program; they fix priorities in this very large equipment through their representatives. For example, 2 military people and 1 NACA man decide what engines get in the altitude-test facilities.

Senator SYMINGTON. Let me ask you a couple more questions, and then I think I will be through.

As to your relationship with private companies, they make contracts with you; is that it?

Dr. DRYDEN. No.

Senator SYMINGTON. You mentioned something about the fact that you did development work for private companies, and it was paid for in the cost of the airplane.

What did you mean by that, exactly?

Dr. DRYDEN. No. I was asked the question about research and development done by private companies, and as to an estimate of the amount of that work. I said I could not do it because in private industry the research and development was part of the overall cost

Senator SYMINGTON. Let me get this straight: If a private company has an order for an airplane, can they come to you and have the development work done?

Dr. DRYDEN. They cannot. They can go, if it is a military project, to the military project officer; if he agrees and considers in the light of other priorities that this should be gone into by the NACA, then it goes through the Military Department, as a request to the NACA.

Senator SYMINGTON. That work is charged to the cost of the airplane; is that it?

Dr. DRYDEN. No, sir; the work we do comes out of our appropriation. We get no reimbursement of any kind.

Senator SYMINGTON. It comes out of the $53 million?

Dr. DRYDEN. Yes, sir.

Senator SYMINGTON. I think you will find that is not quite clear on the record, the way you said that before. You might check that.

Dr. DRYDEN. I will check it. I should say this, Senator Symington, to make it absolutely complete:

The rules established by the President have for many years provided the possibility of doing work for private companies at cost. The military demands have been such that no work of that kind has been done, certainly for the past 9 or 10 years. The NACA is now developing an operating policy with the military for the unitary plan wind wind tunnels which will provide that if a company wants to develop a civil aircraft, and get wind tunnel time, they will pay for the cost of the work.

Senator SYMINGTON. One other question: How do you figure priorities, if you have 2 or 3 companies? Is that figured by your overall Board or by Executive decision?

Dr. DRYDEN. It is done by a man at Wright Field who has charge of all Air Force projects, a man from the Bureau of Aeronautics, a Navy man, and a NACA man.

Senator SYMINGTON. A group of three people?

Dr. DRYDEN. Yes.

Senator SYMINGTON. They decide how to allocate the work priority?

Dr. DRYDEN. They do the horse trading. If the Navy and the Air Force both have a project on which they want time, they discuss it as a little group and work it out between themselves; it works extremely well.

Senator SYMINGTON. Thank you.

Chairman SALTONSTALL. Are there any further questions?

Senator CASE. May I suggest that there is a possibility, although I am nothing more than a layman, that in this proving of flutter, when he says his tunnels are designed to study that, and a strain in and around that area, I remember how I used to think about an old model T, how at practically any speed it would flutter, after it once got going.

Dr. DRYDEN. There is a certain amount of instability there, of course, except there was no air force.

Chairman SALTONSTALL. Thank you.

If there are no other questions, the committee will go into executive session to consider the respective bills.

I ask that the room be cleared.

(Whereupon, at 11:30 a. m., the committee went into executive session and voted to report an original bill, which follows along with the Senate report thereon.)

[S. 1805, 83d Cong., 1st sess.; Rept. No. 22]

A BILL To promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That pursuant to subsection (b) of section 1 of Public Law 672, approved August 8, 1950, the National Advisory Committee for Aeronautics is authorized to acquire land, undertake additional construction, and to purchase and install additional equipment at the following locations:

Langley Aeronautical Laboratory, Hampton, Virginia: Transonic tunnel boundary-layer system, variable Mach number facility, and substation expansion, $3,235,290.

Pilotless aircraft station, Wallops Island, Virginia: Preflight jet heat accumulator, $310,000.

Ames Aeronautical Laboratory, Moffett Field, California: Modernization of supersonic tunnel, $990,700.

Lewis Flight Propulsion Laboratory, Cleveland, Ohio: Acquisition of not to exceed ten acres of land, $10.

SEC. 2. Any of the approximate costs enumerated in section 1 of this Act may, in the discretion of the Director of the National Advisory Committee for Aeronautics, be varied upwards 10 per centum and, with the concurrence of the Director of the Budget, by such further amounts as may be necessary to meet unusual cost variations, but the total cost of all work so enumerated shall not exceed $4,536,000.

SEC. 3. There are hereby authorized to be appropriated not to exceed $4,536,000 to accomplish the purposes of this Act.

[S. Rept. No. 212, 82d Cong., 1st sess.]

AUTHORIZING CONSTRUCTION OF AERONAUTICAL RESEARCH FACILITIES BY THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The Committee on Armed Services, having had under consideration the matter of effective aeronautical research, report the bill (S. 1805) to promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research, and recommend that it do pass.

PURPOSE OF THE BILL

The purpose of the bill is to provide the National Advisory Committee for Aeronautics with the necessary authorization to enable it to carry out its construction program contemplated for fiscal year 1954.

The bill would authorize the appropriation of not to exceed $4,536,000 for the technical facilities required and acquisition of 10 acres of land.

EXPLANATION OF THE BILL

National Advisory Committee for Aeronautics

This committee was originally authorized by the act of March 3, 1915. Its organization and functions were brought up to date by the act of May 25, 1948.

The committee is composed of not to exceed 17 members, all appointed by the President and all serving as such without compensation. The membership of the committee includes representatives from the Air Force, the Navy, Civil Aeronautics Administration, the Smithsonian Institution, the United States Weather Bureau, National Bureau of Standards, Research and Development Board and not more than 7 other members selected from persons "acquainted with the needs of aeronautical science or skilled in aeronautical engineering or its allied sciences."

The general purposes of the Committee are indicated below:

Coordinate the research needs of aviation, civil and military.

Prevent duplication in the field of aeronautical research.

Conduct, under unified control of the Committee, scientific aeronautical research, including:

(*a*) Special investigations in the nature of applied research on problems submitted by the Air Force and Navy for immediate improvement in performance of military and naval aircraft.

(*b*) Fundamental researches instituted by the Committee on its own initiative or authorized upon request of the Air Force, Navy, or Civil Aeronautics Authority to increase speed, safety, and economy of operation of aircraft, military and civil.

Advise the Departments of the Air Force and Navy, the Civil Aeronautics Authority, and the aviation industry as to the latest research information.

Consider merits of aeronautical inventions submitted by the public to any agency of the Government.

On request of the President, the Congress, or any executive agency, to advise upon any special problem in aeronautics which may be referred to it.

Specific authority to undertake construction

Subsection 1 (b) of the act of August 8, 1950, gives to the Committee its basic authority to undertake additional construction. This subsection is the one referred to in the first sentence of the bill and authorizes the Committee:

"(b) to acquire additional land for, undertake additional construction at, and purchase and install additional equipment for, existing laboratories and research stations under its direction;"

General description of the construction authorized by the bill

The construction to be authorized by the bill is summarized below. The general description of the six projects included in the summary is shown immediately following the table:

Summary

Langley Laboratory:	
Boundary-layer control system for 8-foot transonic tunnel	$1,236,200
20-inch variable Mach number facility	1,772,490
Increased capacity for the Stratton Road substation	226,600
Wallops Station: Replacement of preflight jet heat accumulator	310,000
Ames Laboratory: Extending speed range of 1- by 3-foot supersonic tunnel	990,700
Lewis Laboratory: Land acquisition	10
Total authorized by the bill	4,536,000

Langley Laboratory

The installation of a boundary-layer control system will increase the useful speed range of the Langley Laboratory 8-foot transonic tunnel to include the maximum speeds of existing supersonic tunnels and will permit research on cirical problems in the upper transonic speed range.

The 20-inch variable Mach number facility is for the study of very-high-speed missiles above Mach number 3.5.

The increase in the capacity of the Stratton Road substation will permit the more effective operation of newly completed research facilities at the Langley Laboratory.

Wallops Station

The presence of high temperature and salt atmosphere has scaled and corroded the existing heat accumulator at the Wallops Station; a replacement constructed of nonscaling material will eliminate the necessity of costly repairs to models and delays to research programs.

Ames Laboratory

The installation of an additional compressor and modifications to the existing compressor units and tunnel structure will permit doubling of the maximum speed of the 1- by 3-foot supersonic tunnel at the Ames Laboratory.

Lewis Laboratory

The construction of new runways adjacent to the Lewis Laboratory has made certain portions of the laboratory site unusable for future construction. In recognition of the detrimental effect of these new runways on the NACA, the city of Cleveland has taken all necessary actions on its part to convey title to 9.8 acres of adjacent land to the United States Government for the nominal sum of $10.

The construction outlined generally by the foregoing comments is of a highly technical nature and is discussed in greater detail elsewhere in this report.

Coordination among research programs

The Committee examined in particular detail the degree of coordination among aeronautical research programs which has been effected among the various agencies so as to insure against waste and duplication.

The Committee was informed by the Director of the NACA that the construction authorized by the bill in no sense duplicates facilities which are now available elsewhere. Further, these facilities have been decided upon after consultation with other agencies having responsibility in this field and represent the requirements of a unified and coordinated program.

Interproject transfers

The authority proposed by section 2 of the bill for the making of interproject transfers up to 10 percent of the authorized amount is similar to the authority contained in section 402 of the current military and naval construction authorizations contained in the act of July 14, 1952 (Public Law 534, 82d Cong.).

RECOMMENDATION OF THE DEPARTMENTS

The proposed legislation is recommended by the National Advisory Committee for Aeronautics and has received the approval of the Bureau of the Budget, as is evidenced by the letter of the Director of the National Advisory Committee for Aeronautics to the Vice President which appears below and is made a part of this report.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,
Washington, D. C., March 31, 1953.

Hon. RICHARD M. NIXON,
President of the Senate,
United States Senate, Washington, D. C.

SIR: There is submitted herewith a revised draft of proposed legislation to promote the national defense by authorizing the construction of aeronautical research facilities by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research.

The purpose of the revised draft is to reflect changes in the NACA's 1954 construction program as approved by the Bureau of the Budget on March 25, 1953. The original draft was submitted to the President of the Senate on January 9, 1953.

The revised draft of legislation has the approval of the Director of the Bureau of the Budget, who has advised the committee there would be no objection to its submission to the Congress.

It is respectfully requested that the revised legislation submitted herewith be considered for early enactment by the Congress.

Very truly yours,

HUGH L. DRYDEN, *Director.*

Enclosure.

DETAILED DESCRIPTION OF THE CONSTRUCTION AUTHORIZED BY THE BILL

LANGLEY AERONAUTICAL LABORATORY

BOUNDARY-LAYER CONTROL SYSTEM FOR THE 8-FOOT TRANSONIC TUNNEL

It is proposed to install a bounday-layer control system for the 8-foot transonic tunnel. The system will include a 4,000-horsepower electric motor driving a 74,000-cubic-feet-per-minute compressor which will be located in a bypass duct. Electrical connections and water-cooling equipment will be provided.

In order to provide detailed design information needed for bomber and interceptor-type aircraft, the NACA invented a so-called ventilated throat which enabled wind tunnels to operate continuously through the speed of sound. By modernization plus the invention and application of an entirely new concept, two of our older wind tunnels have now been made useful in the heretofore "untouchable" transonic speed range. The speed range now obtainable covers the entire subsonic part of the transonic range and a part of the supersonic portion of the transonic range. Supersonic tunnels can touch only a part of the upper transonic range and do this only by a considerable sacrifice of model size. There is then a gap between the normal useful range of the supersonic tunnel and the speeds attainable by our modernized older tunnels. The Langley 8-foot transonic tunnel was the first large-scale wind tunnel to utilize a ventilated throat, and this tunnel has been providing information in the transonic speed range up to low supersonic speeds. There exists a relatively unexplored speed range extending from the present maximum speed of the 8-foot transonic tunnel to the somewhat higher minimum speeds of purely supersonic tunnels.

Heretofore, increasing the speed of tunnels has been accomplished by an increase in tunnel drive motor power. This involves, however, design and construction changes which are not only expensive but, in addition, require considerable time during which the tunnel is out of service. By a new concept nearly as revolutionary as the NACA transonic throat and made possible only as a result of this invention and development, the speed deficiency that now exists can be eliminated with little interruption of tunnel operation. This new concept provides a method for increasing maximum speeds by removing part of the tunnel boundary-layer air by means of compressors which will handle only this energy-deficient air. Experimental information obtained in the 8-foot transonic tunnel has demonstrated that this new concept will increase the top speed more efficiently than additional fan power.

Addition to the proposed compressor to the 8-foot transonic tunnel will provide a maximum test section Mach number overlapping slightly the minimum Mach number of supersonic tunnels. Data obtained in this range will solve the most pressing immediate problems. Research airplanes now flying at transonic and supersonic speeds do not have characteristics which are satisfactory for military aircraft; rather, they have pointed out problems which urgently need to be solved. These problems are:

(*a*) Large increases in drag;
(*b*) Severe stability and control changes;
(*c*) Aerodynamic loads and buffeting;
(*d*) Air-intake problems.

Research in the existing 8-foot transonic tunnel has already led to marked reductions in drag near and at the speed of sound. Research at higher speeds must now be carried out to extend the speed range over which such drag reductions can be obtained.

Near the speed of sound, the maneuver capabilities of aircraft have already been extended. However, these capabilities have yet to be realized for the higher speed range, and additional study associated with higher speed phenomena is necessary. At the present time, the maximum lift of a configuration is limited by stability and control problems.

Aerodynamic-loads problems are extremely critical in this speed range because, with increases in speed, the loads increase to a point where structural considerations determine the airplane configuration. Buffeting is largely undetermined in this speed range and, as a result, leads to inefficient design of airplanes. Without aerodynamic loads and buffeting information, the airplanes will be either overstrength, resulting in a penalty in performance due to additional weight, or understrength, which will lead to failure in flight. Because of the detailed nature of the information required, wind-tunnel studies are urgently needed.

With regard to the air-intake problem, one type of highly efficient inlet has been developed for speeds through the subsonic and transonic ranges, and another type has been designed to operate efficiently at supersonic speeds only. The two types of inlets are markedly different in their requirements and physical characteristics. It is desired to effect a compromise between these two types that will have optimum efficiency in both the transonic and supersonic ranges. Work is, therefore, needed, chiefly in the upper transonic and lower supersonic speed ranges, to study methods by which a transition internal flow system merging the advantage of both types of inlets can be devised.

The use of the compressor will also provide important information pertaining to the advisability of using additional compressors with this and other transonic tunnels. It should be noted that this compressor will also permit similar improvements in performance in the new companion 8-foot transonic pressure tunnel at no additional expense.

Cost estimate

Mechanical equipment:	
Compressor, lubricating system	$466, 500
Fluid coupling	85, 800
Precooler and aftercooler	85, 300
Valves, air piping, water piping, and controls	199, 200
Cooling tower and water treatment, including pumps	45, 500
Total, mechanical equipment	882, 300
Electrical equipment:	
Synchronous motor and starting motor	135, 300
Switchgear and auxiliaries	93, 000
Cable, duct bank, manholes	43, 000
Circuit breaker	21, 500
Total, electrical equipment	292, 800
Foundations:	
Demolition	1, 300
Excavation, foundations for motors, compressors, etc	44, 400
Concrete basin and piles	15, 400
Total, foundations	61, 100
Total estimated cost	1, 236, 200

TWENTY-INCH VARIABLE MACH NUMBER FACILITY

It is proposed to install a 20- by 20-inch intermittent flow apparatus with a Mach number range of 2.0 to 6.5 in an existing jet room in the gas dynamics laboratory. The apparatus will include a settling chamber, test section, and a variable-area adjustable nozzle. It will be powered by air-storage vessels with a combined capacity of approximately 50,000 cubic feet of air at 550 pounds per square inch which will be erected adjacent to the gas dynamics laboratory and which will be charged by the recently installed 18,000-horsepower blowers in the internal flow laboratory. An air dryer will be installed to remove moisture in the charge air from the blowers. An air heater will be installed for use at Mach numbers above 5.0 to prevent liquefaction of air in the test section.

Increases in the design speed of supersonic guided missiles are being dictated by tactical requirements. In addition, recent detailed studies of ram-jet- and turbojet-propelled missiles have revealed that, for the longer ranges, optimum performance is achieved at Mach numbers of the order of 3.5 or higher. This situation has led to increasing demands for research data, particularly at Mach numbers in the range from 2.0 to 4.0, and also at higher Mach numbers.

Exploratory analytical studies of long-range, very high speed missiles show that for the longer ranges greater overall economy is obtainable with rocket propulsion than with the other propulsion methods. Such rocket-propelled missiles attain very high speeds; Mach numbers in the range of 5.0 to 10.0, and in some cases above 10.0, are reached. It is of great importance to obtain research data in this speed range upon which to base realistic detailed assessments of the potentialities of such missiles. The Langley 11-inch hypersonic tunnel operates at present with a fixed nozzle at a Mach number of 7, and is capable of operating

in fixed increments to a Mach number of about 10 by provision of new nozzle blocks. No facility is available at the Langley Laboratory for the speed range from 4 to 7. Thus, the speed range of the proposed facility, M=2.0 to 6.5, would essentially bridge the gap between the supersonic tunnels now available for Mach numbers up to about 2.0 and the hypersonic tunnel.

Virtually all of the existing larger supersonic wind-tunnel facilities have maximum Mach numbers of the order of 2.0. The only facilities at the Langley Laboratory capable of speeds in the range of Mach numbers appreciably above 2 are the following:

9- by 9-inch jet (for M=4 only)

Capable of only five 1-minute runs per 8-hour day.

Gas dynamics jets, M=2.0 to 4.0

These small jets, which range in size from 1 by 1 inch to about 9 by 9 inches, are operated for a total running time of only a few minutes per day, and are comparable in this respect to the M=4.0 jet.

No facility is available for the range M=4.0 to 6.5.

In these small jet facilities, the scope of research is limited by the small size of models employed and the very short duration of the test. The small size limits the research program to investigations of small models of aircraft components or limited exploratory investigations of complete configurations. For complete configurations, the determination of control surface characteristics, downwash, and wing-body interference effects requires detailed aerodynamic surveys and elaborate model construction which cannot physically be obtained in these facilities. In addition, certain types of research, such as boundary-layer and heat-transfer studies, which require equilibrium conditions to be attained, cannot be conducted with the short test duration available.

The proposed 20-inch facility would permit a significant increase in the scope of supersonic research. Although it would be an intermittent-operation facility, it would have test durations and an operating frequency that would allow extensive research programs at speeds now obtainable for only brief periods in the much smaller existing facilities noted above. At M=4 and a stagnation pressure of 200 pounds per square inch, for example, a run of 7 minutes duration will be possible. About 23 minutes will be required to recharge the air-storage tanks for a typical run, and a large amount of running time per day will be possible without serious interference to the normal use of the compressor system in internal flow research.

It will be necessary to provide air-storage tanks for this facility because there are no existing air-storage facilities at the laboratory of sufficient capacity. The new ultra-high-pressure air (storage) supply of the gas dynamics laboratory was designed for use in critical gas dynamics research at very high Mach numbers, and is totally unsuited for systematic aerodynamic research of the type discussed herein. It would be able to operate a 20- by 20-inch test section at M=3.0 and 20 atmospheres stagnation pressure for only three 1-minute runs per 8-hour day with virtually no air supply left for the gas dynamics research which is also necessary. The new compressor system in the internal flow laboratory would be adequate for continuous operation of only a small test section, 6 by 6 inches, at M=3.0. This compressor system is, however, ideally suited for charging a larger air-storage system in a relatively short time.

To utilize the internal flow laboratory compressor system for the proposed facility will require installation of a dryer to remove residual moisture from the compressed air. An air heater is indispensable for operation beyond M=5.0 to prevent air liquefaction. In fact, some heat addition may be necessary for Mach numbers approaching 5.0 as indicated by recent experiments at the Ames and Lewis Laboratories. The need for such heating has been conclusively demonstrated by experience obtained in the 11-inch hypersonic tunnel and elsewhere which showed that liquid air particles existed with unheated air. With liquid air particles present, it was found that valid calibration of the air flow could not be obtained and that larger anomalies existed in the aerodynamic behavior of test models. None of the existing air heaters at this laboratory are capable of operation with the large air flows required in the proposed facility. Because of the intermittent operation of the proposed facility, it is possible to use an accumulator-type heater of relatively low power (about 2,000 kilowatts) which will provide the necessary heating at minimum cost and minimum power interference with other facilities at the laboratory.

The variable-area feature of the nozzle included in this proposal is indispensable to effective utilization of the proposed air-storage stystem. Because of the wide

Mach number range covered in this facility, the use of numerous sets of fixed nozzle blocks is impractical. For example, for each model configuration at least six nozzle block removals and replacements would have to be made for each test through the speed range. This procedure is time consuming and costly, and would seriously limit the usefulness and research production of this facility. A further extremely important advantage of the variable-area nozzle is that it makes possible continuous coverage of the speed range in contrast to the few specific speeds obtained with fixed nozzle blocks. Thus, the exact flight speeds of specific designs can be simulated and aerodynamic phenomena senstitive to speed changes can be investigated in full detail.

Cost estimate

Test section, nozzle blocks, and control system	$110,000
Settling chamber and adapter	23,100
Model support and diffuser section	25,300
Pressure vessels	778,690
Dryer and piping	257,400
Filter and back pressure valve	19,800
Power supply, transformer, and controls	292,000
Heater	183,700
Foundations	82,500
Total estimated cost	1,772,490

INCREASED CAPACITY FOR THE STRATTON ROAD SUBSTATION

It is proposed to increase the capacity of the 22,000-volt distribution bus at the Stratton Road substation from 33,333 kilovolt-amperes to 50,000 kilovolt-amperes. Structural and electrical modifications will be made to install a third 22,000-volt transformer, including regulators, circuit breakers, and control equipment. This installation will make use of an existing transformer now in use as a grounding transformer which will not be needed for that purpose after 1952.

New facilities constructed during the past few years have involved major electrical installations requiring large amounts of power. With the exception of the 4- by 4-foot supersonic pressure tunnel and the 16-foot transonic tunnel, all major research facilities are served by the 22,000-volt bus at the Stratton Road substation. The total connected load served by this bus is being increased from 58,500 kilowatts to 109,500 kilowatts by facilities being completed in 1952. In order to properly supply this increase in connected load, it is necessary to increase the capacity of the bus from 33,333 kilovolt-amperes to 50,000 kilovolt-amperes.

Power requirements at Langley consist of two parts, a more or less constant or base load and a varying load imposed by the operation of research facilities. The distribution of the connected load by facility is shown in the following table:

[Kilowatts]

Facility	January 1952	December 1952
Base load	7,500	7,500
8-foot transonic tunnel	18,000	18,000
7- by 10-foot high-speed tunnel	11,000	11,000
Frequency converter station	6,000	6,000
Full-scale tunnel	8,000	8,000
19-foot pressure tunnel	8,000	8,000
8-foot transonic pressure tunnel		25,000
Internal flow laboratory		16,000
Gas dynamics laboratory		10,000
Total	58,500	109,500

As research facilities do not operate continuously, it is possible by efficient scheduling to effectively operate facilities whose total connected load is considerably in excess of total power available. Experience has indicated, however, that the power available should not drop below 50 percent of the total connected load if delays in tunnel operation are to be avoided. As indicated above, the total connected load in December 1952 will be about double that in January 1952. With available power limited to 33,333 kilovolt-amperes, the ratio of power available to connected load will drop to about 30 percent. This low ratio of

power available to connected load normally would limit seriously the ability to maintain operating schedules. No difficulty is expected from this source in the fiscal year 1953 as operations are being curtailed because of reduced appropriations.

In the fiscal year 1954, an acceleration of research effort is planned and, by January 1954, the present limited capacity of the substation is expected to prove insufficient; the additional substation capacity that will be provided by this project should be available before this limitation in power becomes critical.

Cost estimate

Structural modifications to substation	$15,700
Regulators	91,800
110-kilovolt circuit breaker	41,600
35-kilovolt circuit breaker	15,800
Modifications to existing transformer	14,400
22-kilovolt disconnecting switches	8,600
Bus structure and lightning arresters	11,300
Metering and control equipment	27,400
Total estimated cost	226,600

Wallops Station

REPLACEMENT OF PREFLIGHT JET HEAT ACCUMULATOR

It is proposed to install a new heat accumulator in the preflight jet at the Wallops Island Station replacing the existing heat accumulator. The accumulator will be constructed of a nonrusting material such as stainless steel.

The preflight jet at Wallops Island is a facility that provides a supersonic jet at sea-level density and temperature for preflight testing and calibration of ram-jet engines, inlets, aerodynamic heating studies, and other aerodynamic research requiring true sea-level conditions. This facility is unique in this respect and obtains this type of jet from the use of a heat exchanger through which air stored in two large spheres is discharged before expanding through the supersonic test nozzles. The air is so heated in the heat exchanger that the expansion process in the test nozzle is just sufficient to return the air temperature to sea-level conditions. The testing time is quite short, being of the order of 10 to 20 seconds, and the heat exchanger therefore must have a high heat capacity and be able to transfer this heat to the air quickly. The present heat exchanger consists of 39,000 steel tubes with electrical heating elements spaced symmetrically throughout the tubes. This was a relatively new and untried method when first built and consequently it was believed justifiable to use relatively inexpensive steel tubes. The past 3 years of almost continual operation have proved the effectiveness of the basic system, but have revealed a fault which it is now proposed to correct. The fault is that the high temperature in the heat exchanger and exposure to atmospheric air cause a continual scaling and rusting of the tubes. The use of a nonscaling heat exchanger is proposed to eliminate this problem. Simple cleaning of the existing tubes only provides temporary relief and delays research.

Rust, scale, or any other particles in the supersonic jet impinging upon the test models rapidly erode the surface and necessitate frequent and costly repairs to these expensive highly polished models. In some cases, the erosion is so severe as to render any testing impossible. One vital research project involving the calibration of a missile-guidance system had to be abandoned because the presence of rust particles interfered with the test. The use of screens and a settling chamber has been tried to cure the difficulty, but has not been successful.

The preflight jet is the only supersonic facility having sufficient size and true sea-level air characteristics that is available at either Langley or Wallops for preflight testing of the ram-jet engines which are vital to the success of ram-jet-powered flight models.

Cost estimate

Heat accumulator	$240,000
Installation	70,000
Total estimated cost	310,000

Ames Aeronautical Laboratory

EXTENDING THE SPEED RANGE OF THE 1- BY 3-FOOT SUPERSONIC TUNNEL NO. 1

It is proposed to modify the wind-tunnel drive of the Ames 1- by 3-foot supersonic tunnel No. 1 to permit an increase in the maximum attainable Mach number from 2.2 to 4.0. This will require the installation of additional drive equipment and changes in the existing drive to increase its rating.

The additional drive equipment will consist of a centrifugal compressor driven by a wound rotor induction motor of 9,000 horsepower. Slip regulation will permit sufficient adjustment of speed to accommodate both parallel and series operation with the existing compressor units. Supplementing the additional drive unit, the existing drive motors will be modified to permit forced-draft cooling of the stator windings. This modification will permit an increase in power output of each unit from the present 2,500 horsepower to 3,000 horsepower. Revisions will be made to the power feeder between the 12-foot pressure tunnel and the 1- by 3-foot tunnel, and from the substation to the 12-foot tunnel to handle the 11,000-horsepower increase in electrical load.

The tunnel structure and location of equipment will be subject to some alteration. An intercooler will be installed before the intake of the fifth compressor for the high Mach number operating condition with this unit in series with the existing units. For high Reynolds number operation, with all units in parallel, this cooler will be used to provide the additional cooling required by the increased power consumption. An additional cooling tower cell will be installed adjacent to the existing one outside the building.

Most of the country's supersonic tunnels work in a speed range of up to about twice the speed of sound, with only a scattered few facilities capable of higher speeds. There is particular urgency for extending the operating speeds to cover the range from twice to four times the speed of sound to provide the answers to pressing design problems of several kinds of very high speed aircraft. There is a critical lack of information on many factors which attain great significance in the speed range under consideration. For instance, the large ram pressure that can be attained makes the ram-jet engine superior to the turbojet. Additional research is required, particularly on airinlet and engine arrangements, to supply the necessary design data for the effective utilization of the ram-jet engine. At these high Mach numbers new types of wings must also be investigated.

The frictional forces created by air flowing over solid surfaces at Mach numbers greater than 2 become increasingly large and demand particular attention. In fact, both the performance and configuration of long-range missiles are, to a large extent, established by considerations of friction. At high Mach numbers, aerodynamic heating, which is a byproduct of friction, assumes great importance. At a speed of 3,000 feet per second (Mach number of approximately 3.0) the temperature rise as a result of aerodynamic heating is about 600° F. With a laminar boundary layer, the heat transfer is about one-third that with a turbulent boundary layer; thus, the heating problem is considerably alleviated by maintaining a laminar layer. At the present time only suggestions of methods by which this can be accomplished are available to the design engineer. Since the problem of the transition of a laminar to a turbulent boundary layer is possibly one of the most complex in all science, much experimental research must be performed to gain the necessary understanding of the mechanism of the flow and to obtain quantitative information. The wind tunnel required for this work must have a wide range of both Mach and Reynolds numbers. The revised 1- by 3-foot supersonic tunnel No. 1 will have this wide range of testing conditions.

Design studies have shown that relatively simple modifications can be made to the 1- by 3-foot supersonic tunnel No. 1 so that this urgently required research can be performed. It has been found that the operating range of the wind tunnel in terms of Mach number and Reynolds number can be tripled by adding the fifth compressor and forced-draft cooling in the existing motors, a modification which can be made at a small fraction of the cost and the time required to build a new wind tunnel. The Reynolds number attainable will be increased by parallel operation in the present range of Mach numbers, and series operation will increase the maximum Mach number from 2.2 to 4.0. These large improvements are possible because the existing flexible-plate nozzle is capable of producing Mach numbers up to 4 and the wind-tunnel shell will permit operation up to 4 atmospheres absolute. Present operation is limited to Mach numbers less than 2.2 and to pressures less than 2.5 atmospheres absolute because of the air handling characteristics of the four existing centrifugal compressors. The proposed modification will make it possible to utilize existing equipment to its full capacity. The cost of the

modifications required is small considering the urgent need for reaserch information and the increased range of testing conditions that will be provided.

Cost estimate

Equipment:	
Motor	$140,000
Liquid speed regulator	71,000
Switchgear, high voltage	71,000
Switchgear, low voltage	17,400
440-volt transformer	6,000
Motor installation	72,000
Compressor	213,000
Gear box	39,600
Cooling tower cell	52,800
Forced-draft cooling system	19,800
Additional cable to substation	58,800
Total, equipment	761,400
Tunnel structure:	
Intercooler and shell	118,800
Valves and piping	66,000
Installation	34,100
Relocation of existing equipment	10,400
Total, tunnel structure	229,300
Total estimated cost	990,700

Lewis Flight Propulsion Laboratory

LAND ACQUISITION

Legislative authority is requested to permit the National Advisory Committee for Aeronautics to accept possession and title to 9.8 acres of land adjacent to the Lewis Flight Propulsion Laboratory. A full description of the area to be acquired is contained in an official deed which has been executed by the city of Cleveland and which reads as follows:

"Official Deed

"from the city of cleveland to the united states of america

"Ordinance No. 395–1952

"Know all these men by these presents, That on the 7th day of April, A. D. 1952, the Council of the City of Cleveland passed Ordinance No. 395–52, entitled "An emergency ordinance authorizing and directing the Mayor to execute and deliver to the United States of America an official deed conveying premises herein described for extension of facilities for aeronautical research purposes," thereby exercising the general powers vested in it and authorizing the conveyance by the City of Cleveland to the United States of America (sometimes hereinafter referred to as the "government"), of the premises hereinafter described; now, therefore,

"Pursuant to the premises, the said City of Cleveland, a municipal corporation in the State of Ohio, for the consideration of ten dollars ($10.00) and other valuable considerations, including the benefits and advantages which will inure to the City of Cleveland by reason of the extension by the government on the premises hereinafter described of the facilities of its airplane engine research laboratory, receipt whereof is hereby acknowledged, does hereby convey, grant, remise, release, and forever quitclaim unto the United States of America, its successors and assigns, the following described real estate:

"Situated in Riveredge Township and partly in the City of Cleveland, County of Cuyahoga and State of Ohio, and known as being parts of Original Rockport Township Sections No. 4 and 5 and Original Middleburgh Township Lot No. 6, Section 20, and together bounded and described as follows:

"Beginning at the intersection of the center line of Grayton Rd., S. W. (60 ft. wide), with the center line of Brookpark Rd., S. W. (100 ft. wide); thence south 89 degrees 09 minutes 48 seconds west along said center line of Brookpart Rd.,

704.03 ft. to the principal place of beginning; thence continuing along said center line south 89 degrees 09 minutes 48 seconds west, 611.00 ft. to a point of curvature; thence northwesterly continuing along said center line on the arc of a circle deflecting to the right 316.98 ft. to a point of tangency said arc having a radius of 955.37 ft. and a chord which bears north 81 degrees 19 minutes 54 seconds west 315.52 ft.; thence north 71 degrees 49 minutes 36 seconds west along said center line of Brookpark Rd., 64.81 ft. to an angle point in Parcel No. 4 of lands conveyed to the Metropolitan Park Board, by deed dated Nov. 7, 1938, and recorded in Vol. 4913, page 327, of Cuyahoga County Deed Records; thence along the following courses being also courses in common with said Parcel No. 4; north 70 degrees 12 minutes 04 seconds east, 265.71 ft.; north 49 degrees 11 minutes 06 seconds west, 116.28 ft.; north 60 degrees 34 minutes 21 seconds east, 179.11 ft.; north 34 degrees 20 minutes 00 seconds east, 370.56 ft.; south 70 degrees 38 minutes 47 seconds east, 149.70 ft.; north 26 degrees 17 minutes 08 seconds east, 75.00 ft. to the northerly line of land conveyed to the City of Cleveland by deed dated January 2, 1926, and recorded in Volume 3433, page 340, of Cuyahoga County Deed Records, thence north 87 degrees 59 minutes 24 seconds east along said northerly line, 270.00 ft.; thence south 1 degree 10 minutes 03 seconds east 646.09 ft. to the principal place of beginning and containing 9.8 acres of land, be the same more or less, but subject to all legal highways and also subject to easements and restrictions of record; reserving however unto the grantor, its successors, and assigns the following:

"1. An easement and right to enter upon, construct, maintain, use, repair, reconstruct, and enlarge (if necessary or desirable) a sanitary sewer with manholes and other appurtenances in, on, and across the land hereby conveyed, and an easement to enter upon, construct, maintain, use, repair, reconstruct, and enlarge if necessary or desirable) a discharge pipeline and appurtenances in, on, and across said lands, and also construct, operate, maintain, use, repair, reconstruct, and enlarge (if necessary or desirable) a pump together with the necessary pipelines and appurtenances in, on, and across the said land hereby conveyed.

"2. In order to effectuate the purposes of the aforesaid easements, a further easement is hereby reserved in, on, and across the lands hereby conveyed to enter upon, construct, maintain, use, repair, reconstruct, and enlarge (if necessary or desirable) either by the grantor or public utility companies, all lines, pipes, ducts, conduits, and other facilities necessary to provide water, electricity, gas, telephone, and other necessary or desirable utility services.

"As part of the consideration for this conveyance, it is hereby convenanted and agreed by the grantee that the grantor hereby reserves the right to remove, within ninety (90) days from and after the date of recording of this deed, any and all buildings and structures now existing upon the lands herein conveyed to the grantee.

"The grantor hereby grants to the United States of America the right to use without charge, the Cleveland-Hopkins Airport for the landing and taking off of heavier-than-air craft.

"As a part of the consideration for this conveyance, it is hereby convenanted and agreed by the grantor, its successors, and assigns (which covenant shall run with the land), that the grantor will not erect, nor permit to be erected, any structure or structures on the Cleveland-Hopkins Airport that will interfere with or impede full and free access from the land herein described to said airport.

"As part of the consideration for this conveyance, it is hereby covenanted and agreed by the grantee, its successors and assigns (which covenant shall run with the land), that the premises herein conveyed shall be used only for purposes of governmental aeronautical research, including the construction of an extension and equipment of an airplane engine research laboratory.

"As a further part of the consideration for this conveyance, it is hereby covenanted and agreed by the grantee, its successors and assigns (which covenant shall run with the land), that any buildings or structures erected or constructed on the premises herein conveyed shall be so erected or constructed as not to interfere with the use of the Cleveland-Hopkins Airport.

"TO HAVE AND TO HOLD the same unto the said grantee, its successors and assigns, forever as fully and completely as said grantor, by virtue of the presents hereinbefore set forth may, can or should convey the same so that neither the said grantor, nor its successors or assigns, nor any others claiming title through or under it, can or will hereafter claim or demand any right or title to said premises, or any part thereof, but they and every one of them, by these presents shall be excluded and forever barred.

"IN TESTIMONY WHEREOF, the City of Cleveland, by Thomas A. Burke, Mayor, has caused its name and corporate seal to be affixed hereto this 30th day of April 1952.

"CITY OF CLEVELAND,
"By THOMAS A. BURKE, *Mayor.*

"Signed and acknowledged in presence of:
"PATRICIA E. WEIR."

"STATE OF OHIO,
"*County of Cuyahoga, ss:*

"On this 30th day of April, 1952, before me as a Notary Public in and for said county and state, came the City of Cleveland, by Thomas A. Burke, Mayor, who acknowledged the execution of the foregoing deed to be his voluntary act on behalf of the City of Cleveland, and the free act and deed of said City of Cleveland.

"IN TESTIMONY WHEREOF, I have hereunto set my hand and notarial seal at Cleveland, Ohio, the day and year last aforesaid.

"MARY A. VOGT, *Notary Public.*

"My commission expires February 3, 1953."

The city of Cleveland has been using its new east-west runway on the north side of Cleveland-Hopkins Airport for the past 2 years. The use of this runway has made portions of the laboratory area unusable for construction purposes due to safety restrictions as to the height of buildings which can be included within the runway glide path.

At the time the city of Cleveland was first making plans to construct this east-west runway it was recognized by both the city officials and by officials of the Lewis Flight Propulsion Laboratory that this loss of land usable for future development would occur. The city of Cleveland, therefore, proposed to convey to the National Advisory Committee for Aeronautics an area of land to partially compensate for the portion of land made unusable. In addition, another east-west runway will soon be constructed on the south side of the Cleveland–Hopkins Airport and will also make additional areas of the present laboratory site unusable for any future construction.

In recognition of these actions detrimental to the interests of the NACA, the city of Cleveland has now taken all action necessary on its part to convey title of the parcel of land described above to the United States Government. Funds are not included in this estimate submission for the development of this land nor is any development contemplated in the immediate future. Nevertheless, experience has shown the need for long-range planning and the acquisition of this parcel of land for the nominal sum of $10 is considered a most prudent investment.

Cost estimate.—$10.

Upon completion of the committee's consideration of the foregoing items, the committee concluded that each of the items had been justified and should be authorized.

The bill as originally introduced involved an authorization of $14,600,000. The bill as amended authorizes $4,536,000, a reduction of $10,064,000.

The proposed legislation is recommended by NACA and has received the approval of the Bureau of the Budget, as is evidenced by the letter of the Director of NACA, which letter is hereto attached and made a part of this report.